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ABSTRACT

This is a case study of one teacher's beliefs, practice, and learning during his first year of participation in a problem-centered second-grade mathematics project. The teacher in this study attempted to implement an alternative approach to teaching mathematics that differed dramatically from his former practice. This study looks at his former beliefs and practice, his teaching of mathematics during his participation in the project, and the process by which he learned and consequently changed his beliefs and practice. The teacher in this study learned and consequently changed his beliefs and practice through his actual practice. Paradigm cases often consisted of alternative interpretations of classroom incidents. (Author/MKR)

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ONE TEACHER'S LEARNING: A CASE STUDY OF AN ELEMENTARY TEACHER'S BELIEFS AND PRACTICE

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This is a case study of one teacher's beliefs, practice, and learning during his first year of participation in a problem-centered second-grade mathematics project. The teacher in this study, attempted to realize an alternative approach to teaching mathematics that differed dramatically from his former practice. This study looks at his former beliefs and practice, his teaching of mathematics during his participation, and the process by which he learned and consequently changed his beliefs and practice. The teacher in this study learned and consequently changed his beliefs and practice through his actual practice. Paradigm cases often consisted of alternative interpretations of classroom incidents.

Teachers' development of beliefs and knowledge is synonymous with teachers' learning. Teachers learn as they reflect on and reorganize their knowledge, and modify their previously taken-for-granted practices. Teachers, like students, are considered as active reorganizers of their experiences who actively construct knowledge. This social constructivist perspective on teacher development draws on student development (Bauersfeld, 1995; Cobb, 1989) as a source of analogies, a position that ties connected perspectives to a common, consistent, theoretical foundation of how people learn.

Teachers are viewed as learners, not as empty vessels to be filled. Mathematics educators often attempt to fill the vessel by supplying teachers with research knowledge or modeling the direct results. However only opportunities for teachers to learn can be provided. The most productive opportunities for teachers' learning arises in the course of their practice as they interact with students. Consequently, this is where teacher/researcher interaction is most vital. This paper attempts to illustrate how the teacher in this study learned and markedly changed his practice and beliefs.

The Case Study

Carl Willis, the teacher in this study, was interviewed and his classroom teaching was video-taped and analyzed over the course of a school year. At the time of the study Carl was teaching second-grade in an inner-city elementary school where he had taught various grade levels for 27 years. Carl expressed and exuded an exuberance for teaching, especially mathematics.

Carl taught arithmetic through extensive drill and practice with a heavy emphasis on flash cards. He indicated that he might do mathematical activities (e.g., flash cards) three times a day: in the morning, the regular lesson, and at the end of the day.

> Ok, I believe in them, [flash cards] drill over these, drill over these ... I would start in September. Every day, every day the good Lord says so ... Lot's of time, at least some of the time when we line up at the door, I would dismiss them by a fact, you

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> know. For them to get out of the classroom, I would ask them [a flash card].
>
> They would really know that [nine plus eight] is 17. They didn't have to take the time... I believe they really understand the basic ones when they come to this [nine plus eight], they didn't have to do all this [counting], they just knew it.

For Carl, if a child knew his facts, that is, he could rapidly answer a series of flash cards correctly, then that child was learning. He believed mathematics was the application of known procedures and basic facts to compute solutions to problems that had already been predetermined.

Carl viewed learning as a process that he could significantly influence. For him, it was important that children were exposed to something if they were going to learn it. For him, learning was like exposing film to the light; an image is left on the film and the more times the film, **or student**, is exposed to the light, the stronger the image becomes. Carl believed that learning consisted of memorizing and, as such, the sequencing and timing of mathematical content was not crucial to students' ability to memorize.

> I always teach my kids that they are the best second graders here at Lincoln School, no matter what class I have [referring to the ability grouping of classes]. To get them to think that. And by me drilling these, these cards every day ... And at the same time I'm telling you [his students], you are the best and they really believe that, so getting them to really think that they are, which they would be ... success, always success, always success you know, in these [the basic facts], every day in math class. I would make them feel like they'd really done something and they really would deserve that and just build that up into them.

Carl made his children feel successful by having them master the facts. More importantly, he believed that his children were successful in mathematics. He sought to instill this belief in his children. Carl attempted to build up the children's self image as a means of motivating the children.

Carl was a caring teacher who helped his students develop proficiency in memorizing the basic facts and through this he also attempted to build his own and children's self image. His focus was on the mathematics, the facts, and through his teaching of the facts he focused on the child. After 27 years of teaching, in which he considered himself to be an excellent mathematics teacher, Carl believed that his former practice was not problematic and that it might only require a slight enhancement. Since he thought of himself as an excellent mathematics teacher, he saw no need to change his practice. He had not volunteered for the project but assumed that he was selected because of his expertise in teaching mathematics.

Carl's Practice

His students had the greatest opportunity to express their mathematical ideas in the initial whole-class activities which were designed to generate a variety of responses and solution methods.

The class was working on Double Ten Frames. Carl had placed four red chips in the left frame and six green chips in the right frame. Carl asked the class what they saw and how many chips there were in all. After they agreed that there were ten in all, the class discussion centered around the idea that one could say four plus six equals ten or six plus four equals ten. Theresa indicated a different way to express the same idea.

Th: You could say, ... it's six on this side [pointing to the right frame] and take one from that side [and] put it on the red side [the left side] ...

T: Listen to her.

Th: And [you] would have five plus five.

T: All right. Do you understand what she [said]? I like that. She said, if we were to take one of these green and put it over here with, with the four [pointing to the four red chips]....you could say five plus five. That's good! (9/25/89)

Carl had created an atmosphere where Theresa could express her ideas. In general, as long as his students arrived at the correct answer, Carl encouraged their creative thinking. As students expressed their varied mathematical ideas he began to see how the instructional activities encouraged students to develop competency and understanding of the basic facts. Although, Carl was still the authority in the classroom, his students began to express their mathematical ideas. Their thinking became increasingly accepted and valued in his classroom.

Carl also became more knowledgeable of the ways that his students used to solve problems and he began to see that there were several ways to solve particular problems. With this new knowledge, he began to have his students explain their solution methods in more detail and to encourage alternative methods. This in turn gave rise to learning opportunities for his students as they explained their thinking.

For example, Carl began one class with a warm-up activity using balances. He wrote several balance problems on the overhead and asked the students how they solved each problem.

T: Let's put, six and seven. Sheryl? [Carl put a six and seven in two boxes on one side of the balance and a blank box on the other side.]

Sh: Thirteen.

T: How did you know? Oh I like that. I love it...

Sh: 6, 7, 8, 9, 10, 11, 12, 13.

T: All right would you [to Theresa] like to tell us something different? ...

Th: I had six plus six is twelve and the six on the right, I just added one more to it.

T: I love it. (9/27/89)

Increasingly, Carl asked students to justify their solutions, "How did you know?". He was aware of how a less able student like Cindy might `count on,' and a more able student like Theresa might use a thinking strategy. What was significant was that he encouraged both students to explain their methods and he was no longer satisfied with just the answer. In Carl's class, mathematical discussion was starting to mean: 'How did you solve the problem, if you have the right answer'.

The following episode contrasts with his prior practice in that he encouraged a student to explain an incorrect solution and he also refrained from directing her to the correct solution. He had written 9 + 10 + 11 on the board and asked the class to solve the problem mentally. In the preceding discussion, two students had given correct answers and their explanations.

T: Someone else who didn't get a chance from last time. Dana.

D: I had 31.

T: How did you get 31? [Carl's tone of voice was much softer than it had been in the past.] (12/15/89)

His actions indicated that he really wanted to know how Dana had solved the problem.

Dana went on to explain that 10 plus nine was 19 and that 19 plus 11 was 31. Carl asked her how she added 19 plus 11. She explained that she had counted. Instead of "straitening" her out he asked the class about her solution. Ralph indicated that 19 plus 12 is 31. However, she still insisted that 19 + 11 was 31.

T: Are you still going to stick with 19 plus 11 would be 31?

D: ... I think that's still 31.

T: If we take, I'm not going to say that! Ha ha. [Carl stopped his question and looked to the back of the room at the project staff member and laughed] (12/15/89)

Carl caught himself in the act of directing a student to the answer. He acknowledged his actions and laughed at his intentions. He had frequently attempted to lead students to a predetermined process, but this was the first time that he stopped to examine this approach. It was as he interacted with his students that the suggestions of the project staff made sense to him. Even though his new practice was induced by the suggestions and comments of the project staff, Carl himself had to do the reflecting and learning.

Carl's Beliefs and Learning

He no longer viewed the correct answer as the most important part of mathematics.

> That's another thing I've learned, too. I was too much hung up on what's right and what's wrong, getting the right answer, and that's not as important as how ... the child or the method they used to get their [solution].

He viewed the processes by which students solved problems as important and, hence, gave students the opportunity to express themselves.

The project staff had noted that one of Carl's slower students could only add by counting on his fingers. In his former practice Carl expected students to memorize the basic facts; now he was being asked to consider how this student could solve problems.

> When she [the project staff member] told me, what really struck me, Travis was only able to count up to five with his [fingers]... When a child, [Travis], will have to say five plus one, he really doesn't know what [he's doing]....He has to say one, two, three, four, five, six....[Drilling with flash cards] he has no real idea what he did....I was denying him the chance....He really didn't understand the relationship.

As this example illustrates, Carl learned and altered his practice as he learned more about how his students solved mathematical problems. His interactions with the project staff influenced him to question his taken-for-granted assumptions about children's learning and his teaching of mathematics. However, his interaction with his students was the primary source of his learning and it was here that the project staff's suggestions began to make sense for him.

Carl indicated that one key aspect of his learning was that he now listened to his students. This enabled him to learn more about how they learned mathematics and, in turn, how to teach mathematics.

> I really didn't listen to the children. I didn't give them an opportunity to express themselves. That's the key thing right there, to be patient and to give them time to express themselves. I think the whole thing is to give...the child an opportunity to...tell how they got their solution to the problem and which I had never really...given a child that [opportunity].

As he learned how his students solved problems, he saw a need for change. Specifically, listening to his students was the basis for much of his learning. This influenced his beliefs about how to teach mathematics.

The project staff attempted to make interventions that might influence Carl to reformulate his beliefs and practice. One means they used was to suggest to him what he might expect from his students. Salient experiences which influenced his learning were specific examples of his students' mathematical activity together with the interpretations offered by the project staff. As previously mentioned, Carl was amazed when he learned that Travis could only add by using his fingers. These became paradigm cases which Carl could verify in his actual practice. Carl had to

learn to listen to Travis to verify the staff's assertions. As Carl learned to listen to his students, he became less dependent on the project staff. He learned about his students' mathematical understandings by interacting with them.

Implications

The Curriculum and Evaluation Standards for School Mathematics, (1989); & Professional Standards for Teaching Mathematics, (1991); have attempted "to establish a broad framework to guide reform in school mathematics in the next decade. In particular, they present a vision of what teaching should entail ...". The project in which Carl participated fits with the recommendations of the NCTM Standards. The NCTM Professional Standards for Teaching indicate what teachers should do and know. However, the Standards do not elaborate in detail how to support this change and develop this vision. "These standards focus on what a teacher needs to know about mathematics, mathematics education, and pedagogy to be able to carry out this vision of teaching" (p. 6). Simply providing teachers with the appropriate knowledge will not be sufficient to transform mathematics education as assumed in the Standards. Reform efforts are destined for failure unless teachers are viewed as active learners, are consequently provided with opportunities to learn in the classroom, and are provided with on-going classroom support.

Teachers learn from their actual practice. Paradigm cases, which often consisted of alternative interpretations of classroom incidents, were important in the teachers' learning. Teachers learned as they used alternative perspectives to explain and make sense of classroom events. In this study the project staff offered these interpretations of classroom events and attempted to encourage the teacher to question his taken-for-granted assumptions about teaching mathematics.

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